AIRBench: A DEA-based model for the benchmarking of airports revenues

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BUSINESS DEVELOPMENT SERVICES

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Agenda

- Our work motivations and contest
- DEA methodology: some concepts
- Airports benchmarking analysis and its application
- Conclusions

Work motivation

- The project arises from the collaboration between the **ORO Group** of the Politecnico di Torino and the **BDS S.r.l.**
- The target is the development of a tool able **to support airport managers** in their activities and measure the **overall assessment of airports performance**.
- Nowadays, airport performance is linked to both **aviation activities** and **commercial activities,** which are becoming increasingly important sector of airport performance.
- The benchmarking analysis allows highlighting airport target and suggesting which sectors airport management should invest on.

The State of the Art

- Many studies have been carried out on the airport benchmarking analysis.
  - Previous studies only focus on aviation activities for the evaluation of airports efficiency.
  - Recently, few articles have considered commercial activities:
    - De Nicola, A., Gitto, S., & Mancuso, P. (2013). Airport quality and productivity changes: A Malmquist index decomposition assessment. *Transportation Research Part E: Logistics and Transportation Review*, *58*, 67-75.
    - Gitto, S., & Mancuso, P. (2010). Airport efficiency: a DEA two stage analysis of the Italian commercial airports.

- The major limit of these more recent studies is that they include **quality indicators** of the Italian *service charter*, defined by the Italian Civil Aviation Authority (ENAC).
  - The *service charter* does not exist for European airports.
  - Their methodology is not easily applicable to European airports.

The Data Envelopment Analysis

- The benchmarking analysis is realized through the Data Envelopment Analysis (DEA) methodology.
- DEA is a non-parametrical and deterministic approach widely used in literature for evaluating the relative efficiency of different decision making units (DMUs), like airports, public or private enterprises, etc.
- DEA models assume the *homogeneity* of the units under evaluation, i.e. the DMUs produce the same type of outputs with the same type of inputs.

DEA models

- The DEA methodology provides many models for the evaluation of the relative efficiency.
  - **CCR model**: it allows to evaluate the **global efficiency**, which is given by the product of the technical efficiency and the scale efficiency.
  - **BCC model**: it allows to evaluate the **technical efficiency**, which measures the DMU efficiency considering its operational capability.
  - The ratio between the CCR and the BCC indices provides the **scale efficiency** index which expresses whether and how much the size of the DMU influences its global efficiency.

Benchmark methodology: Data retrieval process

- The benchmarking uses only data that can be obtained by public available sources and databases
- The data has been retrieved from balance sheets and profit and loss accounts, airports websites and ENAC data.
- Differently from other works in literature, **both the aviation and the commercial activities are considered** to evaluate the airport performance.
  - Main difficulty: the non-homogeneity of the airports balance sheets required a detailed analysis.
  - Occasional and exceptional revenues have been excluded.

Benchmark methodology:

Identification of the best variables for the model

- The plurality of different optimal solutions of DEA required a reiterative process to guide the model towards the solution that better represented the market.
  - Many tests with many different inputs and outputs were carried out in order to find the best variables for the model.
  - A preliminary knowledge of the market was necessary.

DEA Model
Inputs and Outputs

- Input oriented CCR and BCC DEA models.
- Each airport is a DMU.
- We select **4 inputs:**
  - 2 inputs related to the **commercial activities**:
    - commercial surface (Sqm);
    - marketing mix index (mix of service categories of the airport)
  - 2 inputs related to the **aviation activities**:
    - Number of airlines;
    - Accessibility index (Hansen index)
- We select **2 outputs**:
  - 2012 commercial revenues per passenger
  - 2012 aviation revenues per passenger

Benchmark analysis: Application

- Sample of **23 airports**: 18 in Italy and 5 in the rest of Europe .
- The sample is divided into big-sized, medium-sized and small-sized airports.

Big-sized airports >10 million passengers/year	**Medium-sized airports >5 and <10 million passengers/year**	**Small-sized airports <5 million passenger/year**
Hamburg	Bari and Brindisi	Florence
Amsterdam	Bergamo	Lamezia Terme
Athens	Bologna	Olbia
Frankfurt	Catania	Palermo
London Heathrow	Naples	Pisa
London Stansted	Venice	Turin
Milan (Malpensa and Linate)		Treviso
Paris		
Rome (Fiumicino and Ciampino)		
Wien		

Benchmark analysis

- For every airport we evaluate:
  - The **global efficiency**
  - The **technical efficiency**
  - The **scale efficiency**

- **For the inefficient airports**, we realize:
  - **Peers analysis**: the model provides a target airport (peer) that airport managers whose airport is inefficient need to catch up to.
  - **Weights structure analysis**: a detailed analysis of the weights of inputs and outputs is carried out in order to understand which are the main structural differences between the inefficient airport and its target and to find the causes for the inefficiency and some possible corrective actions.

Efficiency indices: Big-sized airports

	DMUs	CCR efficiency	BCC efficiency	SCALE efficiency CCR/BCC	POSITION ON THE FRONTIER	TARGET (PEER) from the CCR model
Big-sized airports	Hamburg	0,507	0,552	0,917	IRS	London Heathrow, Wien, Turin.
	Amsterdam	0,558	0,726	0,769	IRS	London Stansted, Paris
	Athens	1	1	1	CRS	
	Frankfurt	1	1	1	CRS	
	London Heathrow	1	1	1	CRS	
	London Stansted	1	1	1	CRS	
	Milan (Malpensa & Linate)	0,955	1	0,955	DRS	Paris, Wien, Turin.
	Paris	1	1	1	CRS	
	Rome (Fiumicino &Ciampino)	0,594	0,974	0,610	IRS	Paris, Turin.
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It indicates the type of **Returns To Scale (RTS)**: it expresses the direction of marginal rescaling that the DMU should undertake in order to improve its efficiency.

If a DMU exhibits **CRS**, it operates at the most efficient scale size.

If it exhibits **IRS**, it would achieve it by scaling the size of its operations **up**.

If the DMU exhibits **DRS**, it would achieve it by scaling its operations **down**.

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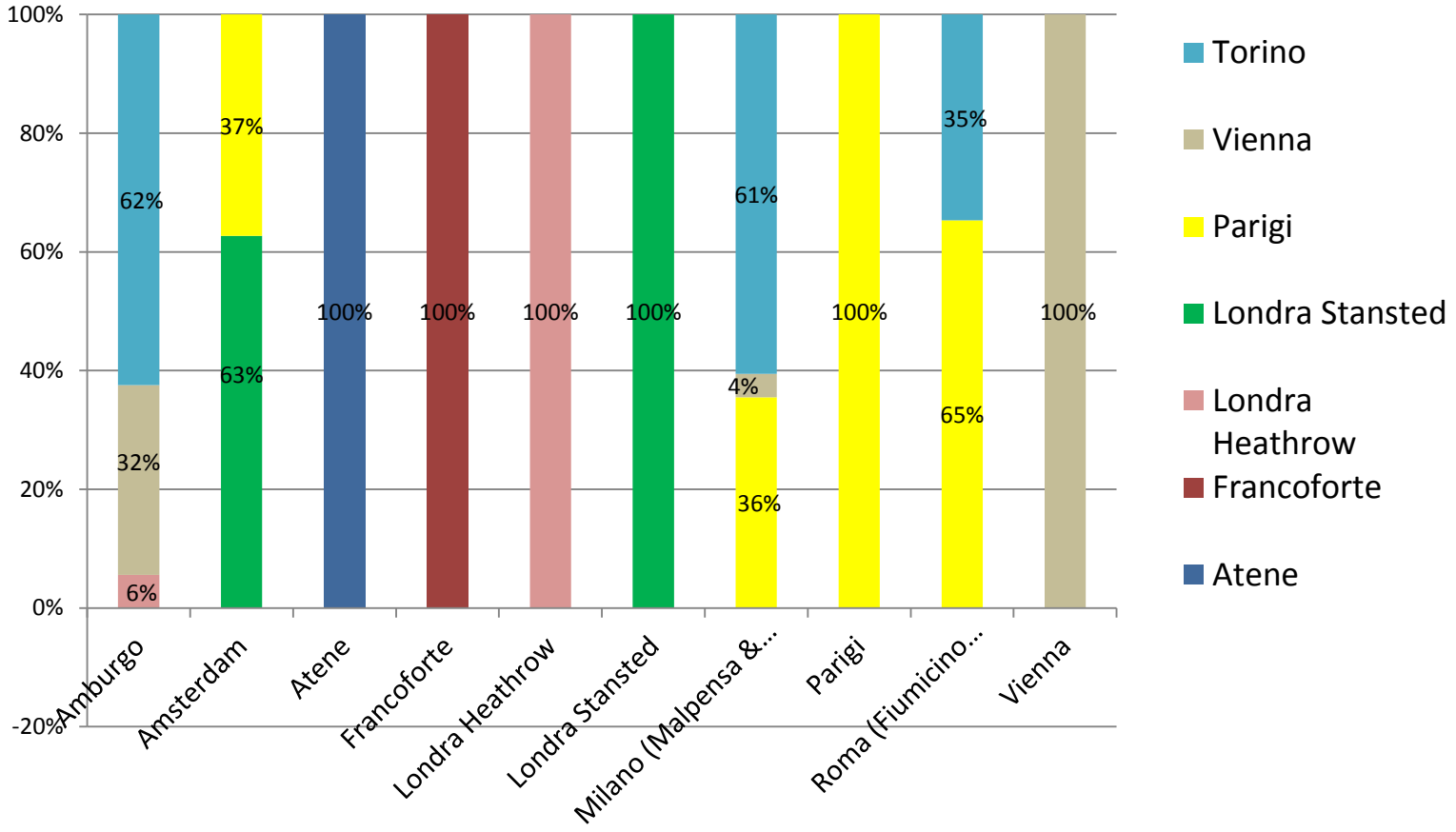
BIG AIRPORTS



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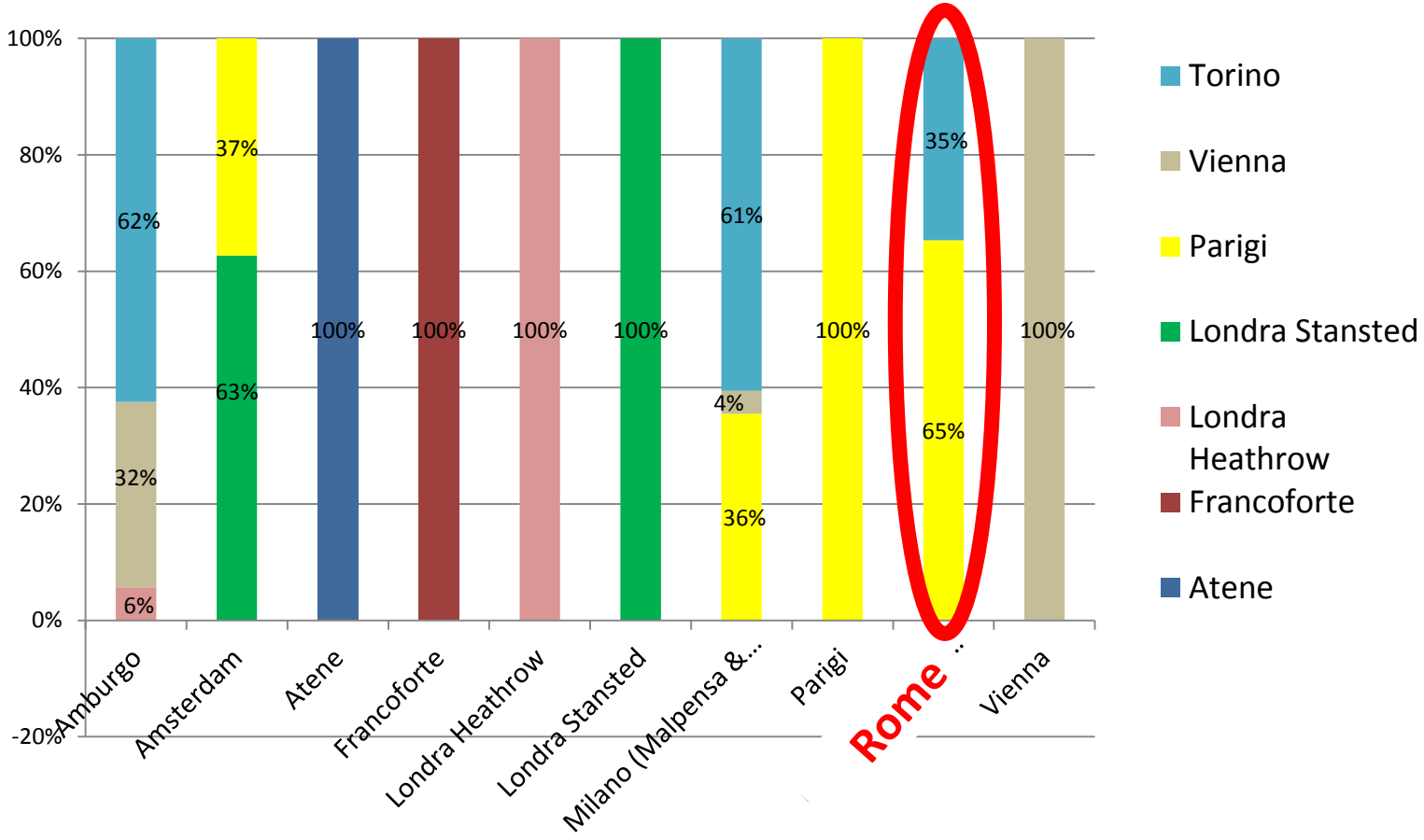

Weights analysis example: ROME AIRPORT

- Analysing the weights of Rome airport and of its peer Paris, we obtain information about the structure of the two airports.
- Rome has the same structure of Paris: the two airports allocate similar weights to the same inputs and outputs.
- Both explain their efficiency using only the commercial activities.

DMUs	2012 Aviation revenues per passenger	2012 Non-aviation revenues per passenger	Commercial surface (Sqm) per passenger	Marketing Mix	Airlines	Accessibility
Paris	0	0,063	1,124	0,001	0	0
Rome	0	0,088	1,927	0,015	0	0

Initial data analysis

- To better understand the weights assignment in the estimation of the efficiency, we consider also the initial data, which provides information on the quantity of sources used and of outputs produced.

DMUs	2012 Aviation revenues per passenger	2012 Non-aviation revenues per passenger	Commercial surface (Sqm) per passenger	Marketing Mix	Airlines	Accessibility
Paris	17,8	15,77	0,197	68,5	139	0,841
Rome	7,7	6,72	0,197	42	149	1,010

- Since Rome has a low marketing mix, revenues result lower than those of its target: **Rome results commercially inefficient.**

Conclusions

- We developed an DEA-based airports benchmarking methodology, which
  - is a standard tool, based on public data
  - considers both **aviation** and **commercial** activities
  - considers both **economic** and **non-economic** data

- Thanks to the DEA-based airports benchmarking:
  - we identified the **overall assessment of airports performance**
  - for airport managers whose airport is **inefficient**, we identified the **target airports** they need to catch up to and which factors they should invest on to reach the efficiency.

Thank you

A DEA-based benchmarking for the evaluation of the efficiency of Italian and European airports.

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